PATENT SPECIFICATION

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COMPLETE SPECIFICATION.

Improvements in or relating to Rotary Earth Boring Tools.

We, HANS LEMBCKE, of 7, Hedwigstrasse, München, Germany, and PAUL SCHMIDT, of 10, Arcostrasse, München, Germany, both German Citizens, do hereby declare the nature of this invention and in what manner the same is to be performed, to be particularly described and ascertained in and by the following statement:—

It is known to drive rotary earth boring tools or drills by a mechanism arranged on the surface of the ground, and by the insertion of lengthy boring rods. This drive has very considerable disadvantages and consequently it has been attempted to actuate the boring tool direct on the bottom or sole of the bore hole by means of special driving devices. Among the several kinds of such driving devices, the present invention relates to a drive comprising hydraulic turbines.

From the well known rules applying to the working of hydraulic turbines, it follows for the conditions which are met with in boring holes in the earth that such turbines of sufficient hydraulic action must be run at about 3000 to 5000 revolutions per minute. The usual speed of earth boring tools or drills amounts, however, to about 50 to 150 revolutions per minute. Up to the present it has been attempted to design a hydraulic drive for rotary earth boring tools or drills only on the assumption of the hydraulically obvious very high numbers of revolutions of the turbines.

Such a drive with turbines with a high number of revolutions has, however, the drawback that it is necessary to provide either transmission gearing or the like which, however, are shown by experience to be unable to stand the severe stresses of the boring work, or to work the drill at a very high number of revolutions. In the latter case, however, the drill wears out too quickly, so that such working also fails to give any technical advantages.

The suitable arrangement of a turbine drive for such boring tools or drills is therefore a problem which had not yet been completely solved. Stated briefly, it is a question of obtaining the greatest possible turbine power with a very small diameter and with a very small number of revolutions of the turbine.

In view of the small diameter and of the small number of revolutions, it is first of all obvious that it is necessary to choose a very small circumferential speed of the turbine blades, or buckets. On the other hand, it follows from the small diameter of the turbine that the quantity of flow per second can also be only small. If in spite of this it is desired to obtain a sufficiently great power, there is no other means left but to make the pressure of the driving liquid correspondingly high. According to the generally known rules of turbine theory, a high driving pressure means, however, a high circumferential speed of the turbine. In the turbine construction which allows of the lowest circumferential speed, namely in the free jet turbine, the circumferential speed must still amount to at least one half of the absolute water velocity.

One means for reducing the circumferential speed consists in making the turbine a multi-stage one. In the conditions obtaining in the case of bore hole working, the number of stages would, however, have to become so large (1000 to 5000) as we have proved by exhaustive calculation that such a construction would be impossible in practice.

For attaining the object it was therefore necessary to look for a radically different turbine construction. The solution has been found by making the speed of flow in the turbine channels or conduits very considerably greater than the circumferential speed of the blades. It amounts to about ten to twenty times the circumferential speed. Only in that way the water exerts a sufficiently great torque on the turbine for developing the desired power even at a low number of revolutions.

The blading in this construction resembles the blading in a steam turbine in which the whole pressure is converted in the guide apparatus or distributor into speed which is then utilised in a series of rotor and guide wheels for imparting the kinetic energy of the steam to the turbine. The bore hole turbine built according

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to the invention is also made with a plurality of stages, but the number of stages is here much smaller than would have to be the case in a normal hydraulic turbine.

With the high speed of flow of the water through the turbine is of course combined a greater loss at the outlet than would be the case in accordance with the normal turbine theory which seeks to make these losses as small as possible. But this loss is unimportant in comparison with the fact that it is possible in this way to build a turbine which, with a sufficiently great power, runs so slowly that it can be used for direct coupling to an earth boring tool. The energy still remaining at the outlet from the turbine is besides not lost but can be utilised with great advantage for flushing away the material bored, for which purpose it is always necessary to have flushing water flowing at high speed.

According to the invention, a bore hole bottom drive for rotary earth boring tools or drills consists therefore in the drive being by a slowly running hydraulic turbine, coupled direct (that is to say without any gearing), in which the driving liquid is carried through a system of guide and rotor wheels with a speed many times exceeding the circumferential speed of the turbine blades.

The speed of flow of the driving liquid is here preferably to amount to ten to one hundred times the circumferential speed of the turbine blades.

The great speed of flow within the turbine ensures moreover, also that the turbine conduits or channels will always be kept clean even when using very muddy water, that is to say, any crust or accretion due to the deposit of mud particles or the like is avoided.

The driving liquid after leaving the turbine may, moreover, be conveyed in a powerful jet directly against the bottom of the bore hole for the purpose of washing away the material bored, this as is well known greatly assisting the process of boring or drilling.

It will be obvious to any hydraulic engineer that in carrying the invention into practical effect, he will have to choose a type of turbine which can produce the great torques such as are required in earth drills for ensuring an economic progress in drilling. A great torque can be, however, produced by a turbine only when care is taken by means of suitable distributors or guide apparatus to ensure that the water will get into the rotor blades or buckets with a high velocity and, as far as possible, in the direction of the force to be produced, that is to say, in the circumferential direction, from which buckets it escapes again, after a deflection to about 180°, also approximately in the circumferential direction.

The regulation of the boring or drilling pressure from the surface of the ground offers great difficulties in the boring processes hitherto known. It has been attempted to render the production of a given boring pressure dependent on the number of revolutions of the drill by means of an automatic regulating mechanism. In the present drive from the bottom of the bore hole according to the present invention such a regulated setting of the boring or drilling pressure is obtained in the simplest possible manner by causing the hydraulic pressure to act on the rotor of the turbine or of the boring tool for the purpose of producing axial forces.

Arrangements for the production of such axial forces are known in themselves as means for thrust equalisation in centrifugal pumps or turbines, but in the present case it is a question not only of influencing the axial thrust of the turbine, but chiefly also the boring pressure. It is obvious that the axial thrust of the turbine can be also utilised for the production of an increased or reduced drilling pressure. but usually the final value of the drilling pressure must be specially regulated by auxiliary devices for the hydraulic production of axial forces. In such a utilisation of the hydraulic pressure for the production of a given force with which the boring tool or drill is pressed against the bottom of the bore hole, it may be further advantageous to make the production of these auxiliary axial forces adjustable by separate control means. For this purpose there may be used for instance an ordinary centrifugal governor which regulates the supply of liquid under pressure to given parts of the arrangement for the hydraulic production of axial forces, in dependence on the number of revolutions of the drill.

When working in practice rotary earth boring tools or drills, it is necessary, as is well known, to take into account that the drill sticks fast. In such cases the direction of rotation of the drill must be reversed, and a raising of the same produced. The present invention provides for the purpose control means by which the admission of the working liquid into the working turbine is shut off, and at the same time a passage opening outside the turbine blades is uncovered. In this way the whole stream of liquid can be guided in a powerful jet against the bottom of the bore hole, without first losing any of its energy to the turbine blades, so that a slight jamming of the drill can be cancelled by the powerful action of the jet

with the drill standing still.

If, however, the tool or drill is very strongly jammed, it will be generally insufficient to stop the rotation of the drill, on the contrary the drill must then be caused to rotate in the direction opposite to that of normal working. To do this, there may be provided a second turbine to which the stream of liquid is supplied after the admission of the working turbine has been closed. This counter-turbine may be generally arranged in any desired position above or below or also combined with the working turbine. It is advantageous to arrange the counter-turbine within the rotor of the working turbine, as in this arrangement the axial extension of the whole arrangement is brought to a minimum value.

The control of the current of liquid for the purpose of stopping the working turbine can be effected from the surface of the ground by means of separate devices.

A construction intended as an illustration of this bore hole bottom drive according to the invention, will be described with reference to the drawings. In Fig. 1 of the drawings, 1 is the supply pipe for the driving liquid of the turbine let into the bore hole, 2 is turbine part of the bore hole bottom drive and 3 the boring tool or drill. The supply pipe for the liquid is connected to the turbine part by the pipe 4 telescopically inserted into the pipe 1. Both pipes are provided with annular collars which prevent the pipe 4 from coming out, and at the same time ensure an exact axial guiding of the pipe 4.

The driving liquid passes at 5 into the first guide wheel ring of the turbine, escapes from the said guide wheel ring at 6 where the liquid has a relatively very high velocity, for instance 30 times the circumferential speed of the turbine blades arranged at 7. From the turbine blades 7, the liquid escapes with a very high velocity into the second guide apparatus or distributor 8 and into the second rotor wheel blading 9 of the turbine. In this way, the driving liquid passes through several guide and rotor blade rings.

The driving liquid escapes from the turbine at 10. The liquid then passes through the slots 11 into the interior of the rotating part and is conveyed by the connecting part 12 formed into a pipe, into the boring tool. The boring tool or drill is connected to the tubular branch 12 by a screw thread or the like so that the boring tool and the rotor of the turbine represent a single rotating part.

Owing to the small number of revolutions of these rotating parts, they can be supported or mounted in a relatively secure and simple manner. At the upper end of the turbine, the rotor runs on a roller bearing 13 which is constantly washed or rinsed with the pressure liquid through the gap 14. The rinsing water passes through the bore 15 into the hollow rotor of the turbine. Similar washing of the bearing is provided at the bottom bearing surrounding the connection part 12. Here the liquid can escape through the gaps 16 and 17 into the bearings and then outside the boring tool.

The bore 15 and the wall 18 provide a hydraulically-operated means for exerting an axial force on the drill, in the sense of increasing the boring pressure. The pressure of the liquid above the wall 18 is higher than at the wall within the rotor, as the liquid in front of the turbine has a greater pressure than after having performed work in the latter. The bore 15 by transferring liquid from the space in front of the turbine into the interior of the rotor produces a more or less efficient balancing of these pressures and can therefore be used for an adjustment or regulation of this hydraulic and axial force action.

Figures 2 and 3 show a modified construction according to the invention. In this construction, the working turbine with the rotor blades 7, 9, and the guide blades 8 is built in the same way as in Figure 1. On the inner side of the turbine rotor is arranged a second series of rotor wheel blades 19, 20 which have the opposite direction of rotation to that of the working turbine. To these rotor wheel blades 19, 20 water is supplied through the guide blades 21, 22 which are secured to a bolt 23 which is rigidly secured by ribs 24 to the outer tube. Above the turbine is arranged a slide valve 25 which can be operated from the surface of the ground by means of rods 26. When the said slide valve is in its lower position shown in Figure 2, the water under pressure coming from the top is supplied to the working turbine 7, 8, 9. This is the position of the slide valve for normal working of the drill. The inner reverse turbine is switched out in this position. If it is desired to produce a reverse rotation of the drill, the slide valve 25 is pulled upwardly by means of the rods 26 into the position indicated in Figure 3. In this position of the slide valve the working turbine 7, 8, 9 is switched out, and the water under pressure is supplied to the reverse turbine 19, 20, 21, 22. From this turbine it escapes downwards through the bore 12.

When it is desired to sacrifice the revers-

ing of the drill, the rotor wheel blades 19, 20 and the guide blades 21, 22 can be omitted. In such a case the slide valve 25 can be utilised for switching out the working turbine 7, 8, 9 and for directing the water under pressure freely through the bore 12 against the bottom of the bore hole.

Figure 4 shows an arrangement for the regulation of the boring pressure. This Figure shows the wall 18 and the bore 15, the object of which has already been stated in the description of Figure 1. The bore 15 is in this case conical and provided with a conical valve 27, the spindle 28 of which is guided in the cross part 29. The spindle is provided at the bottom with a bent projection 30. With this projection 30 engages one arm of the bell crank lever 31 supported in the bearing 32, the other arm of which has a weight 33. In the position of rest, the cone valve 27 is raised by a spring 34 so that the bore 15 is open. When the turbine starts, the weight 33 will be moved outwards by centrifugal force as the number of revolutions increases and in that way the cone valve 16 pressed down, and the bore 15 gradually closed more and more. Owing to the closing of the bore 15, the pressure above the disc 18 will be increased, and therefore the drill pressed with greater force against the bottom of the bore hole.

Having now particularly described and ascertained the nature of our said invention and in what manner the same is to be performed, we declare that what we claim is:—

1. A bore hole bottom drive for rotary earth boring tools or drills, characterised in that the drive is by a slowly running direct coupled hydraulic turbine in which the driving liquid is conveyed with a speed many times exceeding the circumferential speed of the turbine blades through a system of guide and rotor wheels.

2. A bore hole bottom drive for rotary earth boring tools or drills, according to claim 1, characterised in that the speed of flow of the driving liquid is from ten to hundred times the circumferential speed of the turbine blades.

3. A bore hole bottom drive for rotary earth boring tools according to claims 1 and 2, characterised by means for deriving from the liquid pressure of the driving liquid axially directed forces for influencing the boring pressure of the tool.

4. A bore hole bottom drive for rotary earth boring tools according to claim 3, characterised in that the action of the hydraulic pressure of the driving liquid on the boring pressure is regulated by separate control means.

5. A bore hole bottom drive for rotary earth boring tools according to claims 1 to 4, characterised in that separate control means are provided by means of which the admission of the driving liquid to the working turbine can be closed and at the same time a passage opening uncovered outside the turbine blading.

6. A bore hole bottom drive for rotary earth boring tools according to claims 1 and 2, characterised in that in addition to the working turbine, there is provided also a second turbine secured to the same shaft with opposite direction of rotation.

7. A bore hole bottom drive for rotary earth boring tools according to claims 5 and 6, characterised in that, on the control means closing the admission of the working liquid into the working turbine, the current of liquid is conveyed to the counter turbine.

8. The bore hole bottom drive for rotary earth boring tools substantially as described or substantially as shown in the accompanying drawings.

Dated this 23rd day of February, 1931.

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Chartered Patent Agents.

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Fig. 1

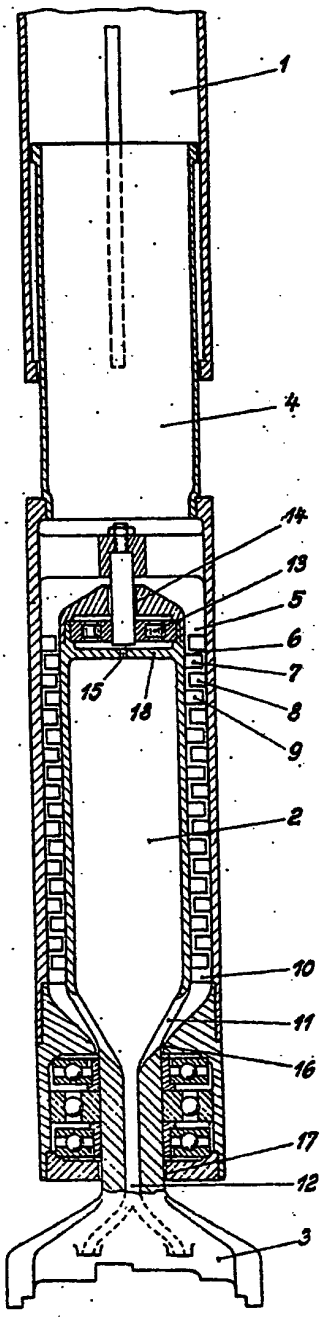

Fig. 2

21
19
22
20

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Fig. 2

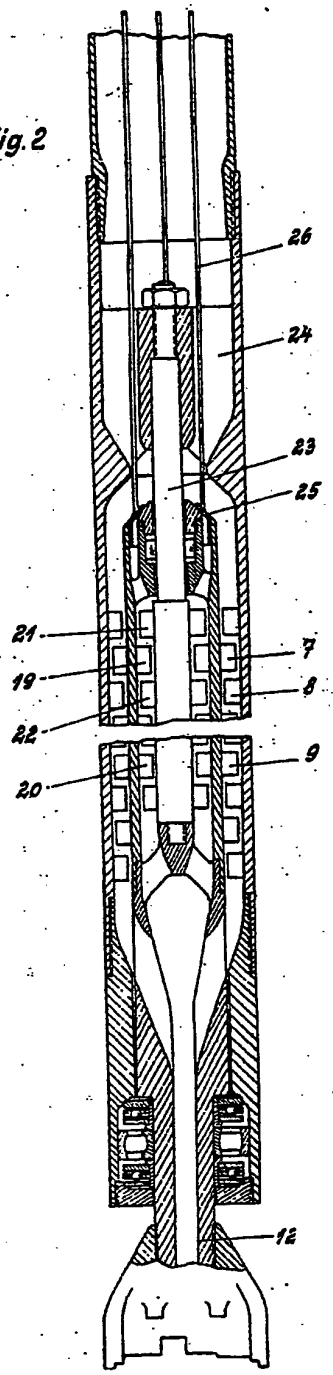


Fig. 3

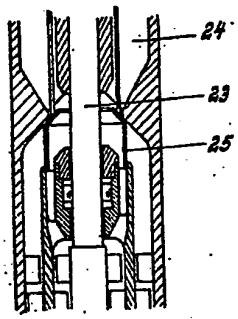
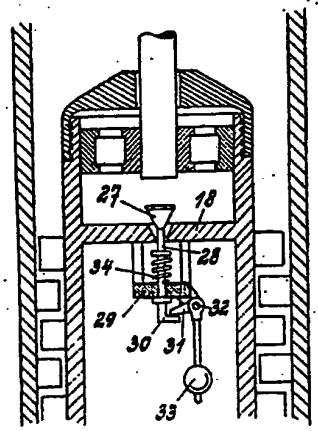


Fig. 4



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3 SHEETS

SHEET 1

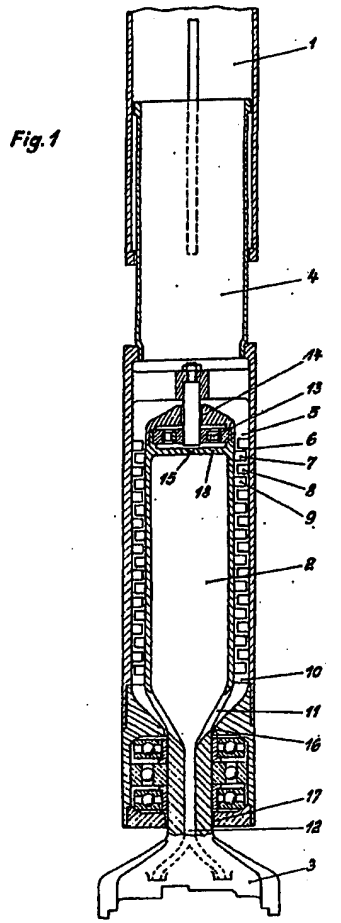

Fig. 1

SHEET 2

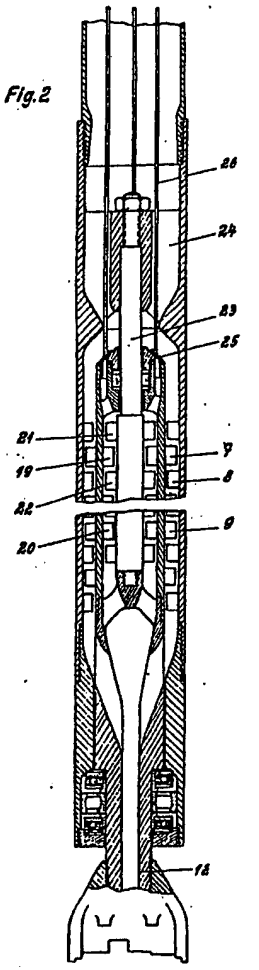

Fig. 2

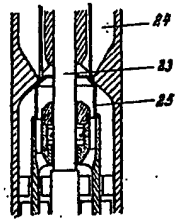

Fig. 3

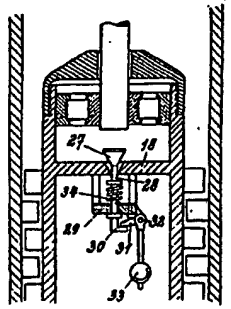

Fig. 4

[This Drawing is a reproduction of the Original on a reduced scale]

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